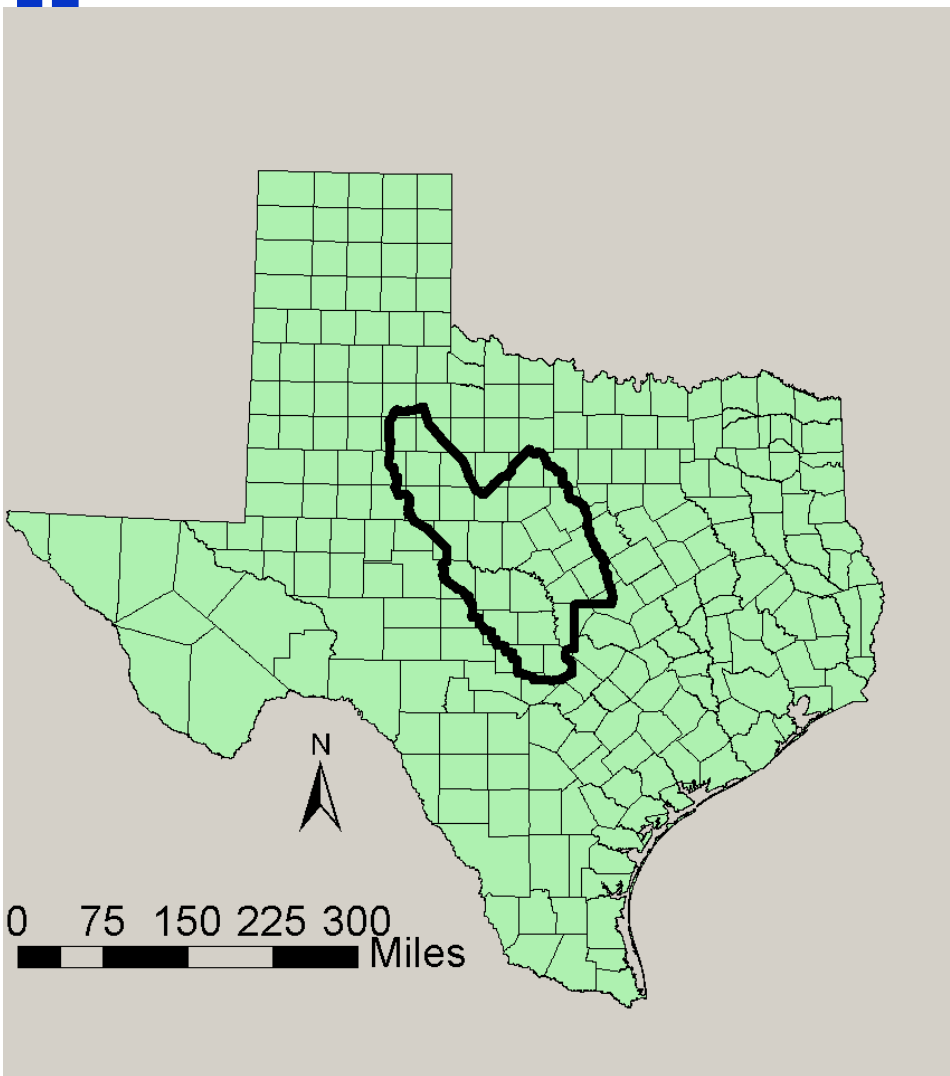
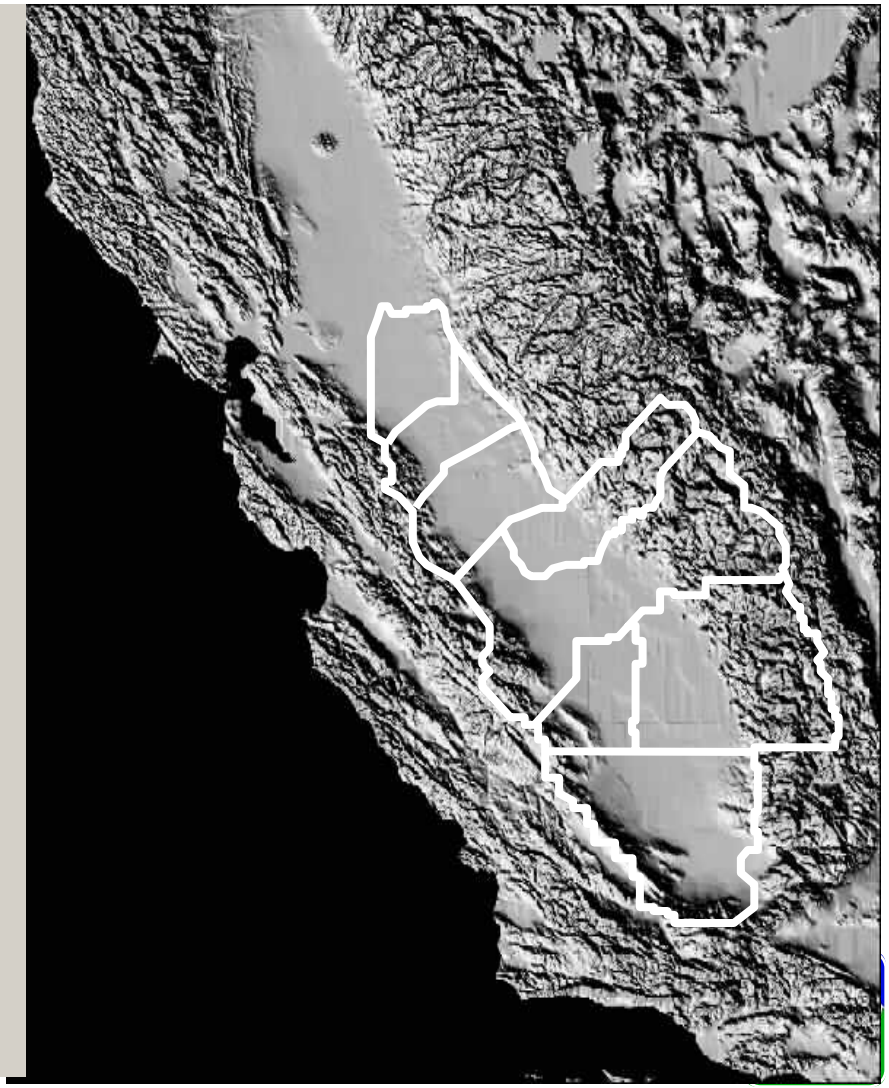
PM2.5 Forecasting in the San Joaquin Valley of California

The San Joaquin Valley of California





APCD Programs Supported by PM2.5 Forecasting

- AQI Forecast in 3 Regions
- Burn day and prescribed burn determination
- Please Don’t Light Tonight
- Special Study Intensive Operations
- Emergency Response

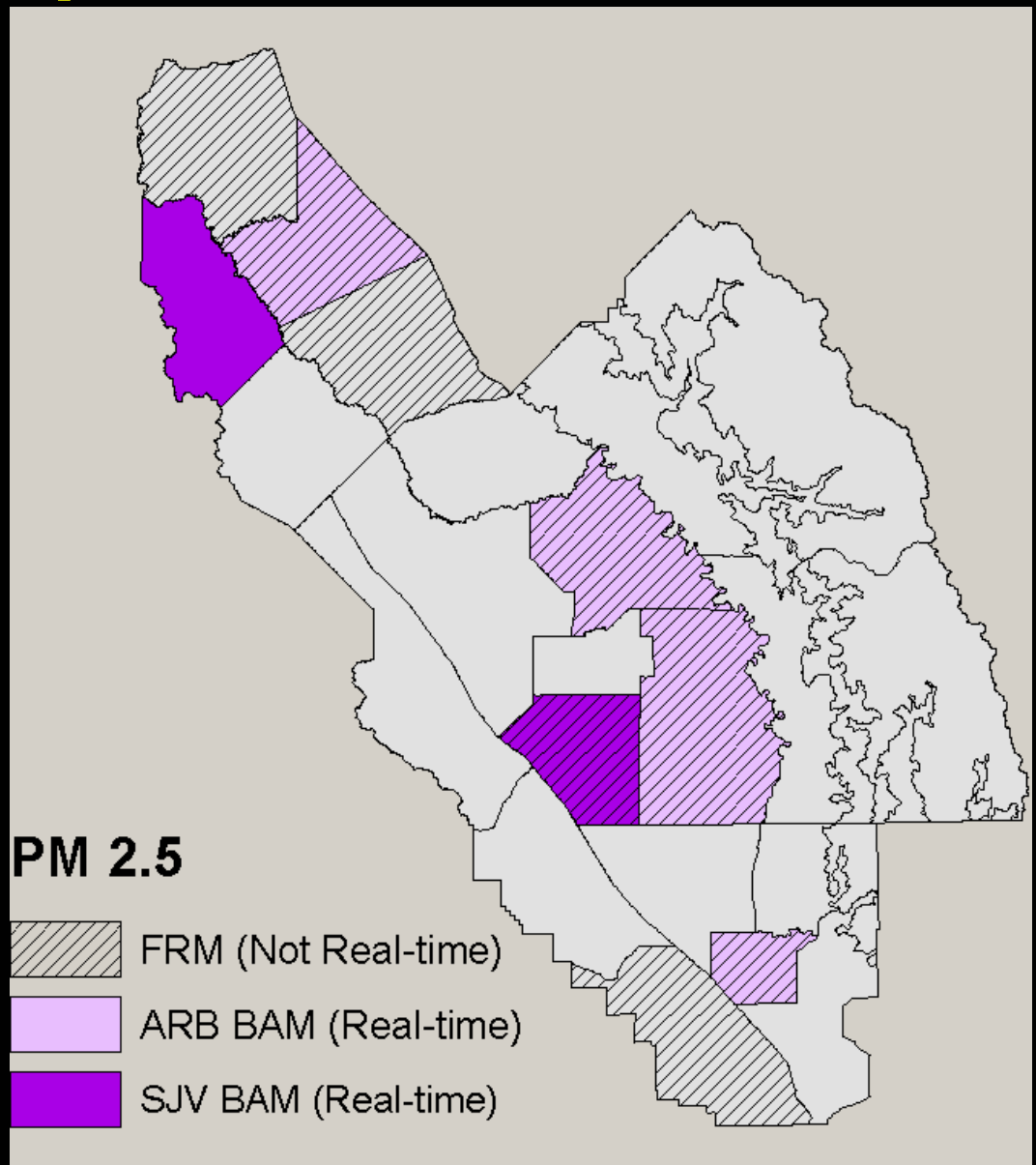
Future Programs Dependent on PM2.5 Forecasts

- Forecasts in 23 Air Quality Forecast Areas
- Burn allocation determination in 99 zones
- Mandatory Don’t Light Tonight
- Special Studies
- Emergency response

Elements of PM2.5 Forecasting

- Understand PM Meteorology using Historical Synoptic and Statistical Analyses
- Understand Chemical Speciation
- Seasonal and Diurnal Emission Characteristics
- Ability to Forecast and Verify Meteorology
  - ✓ Synoptic Scale
  - ✓ Mesoscale Map
  - ✓ Transport and Dispersion

PM2.5 Data Available for Forecast Development and Verification



Winter PM2.5 Episodes In SJVAPCD

- Cold with poor vertical dispersion
- Low wind speeds
- Light fog
- Mostly PM2.5 (>160ug/m3)
- Ammonium Nitrate (>65ug/m3)
- Carbon

Winter Episode Chemical Composite (12/26/00-1/7/01)

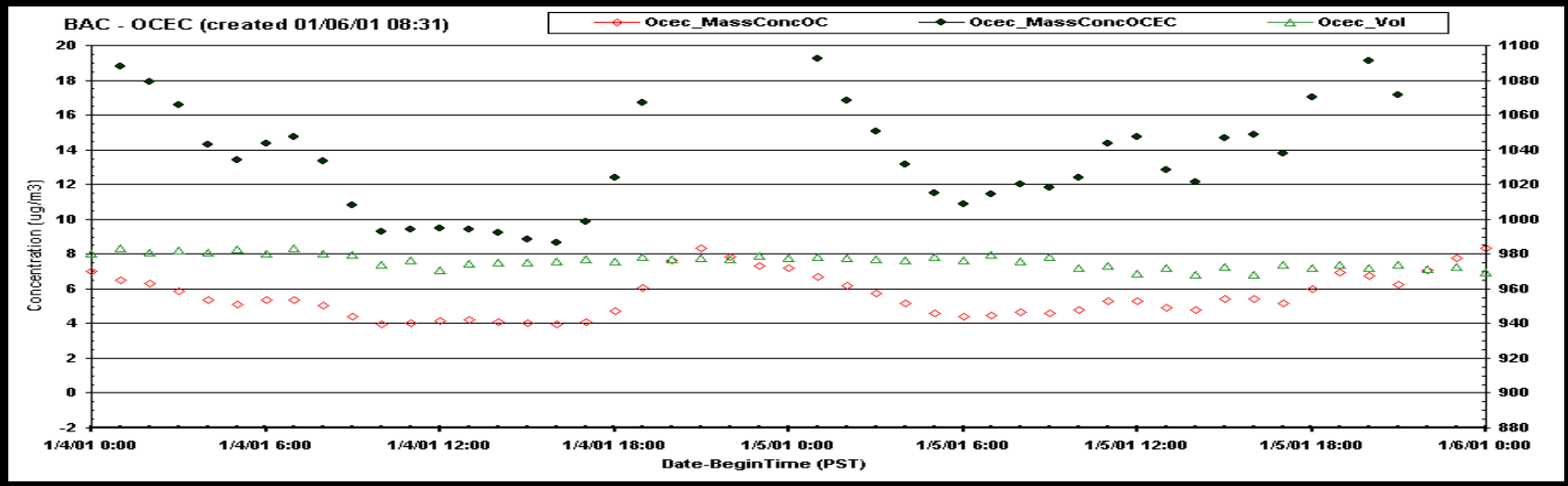
For samples >100 ug/m3

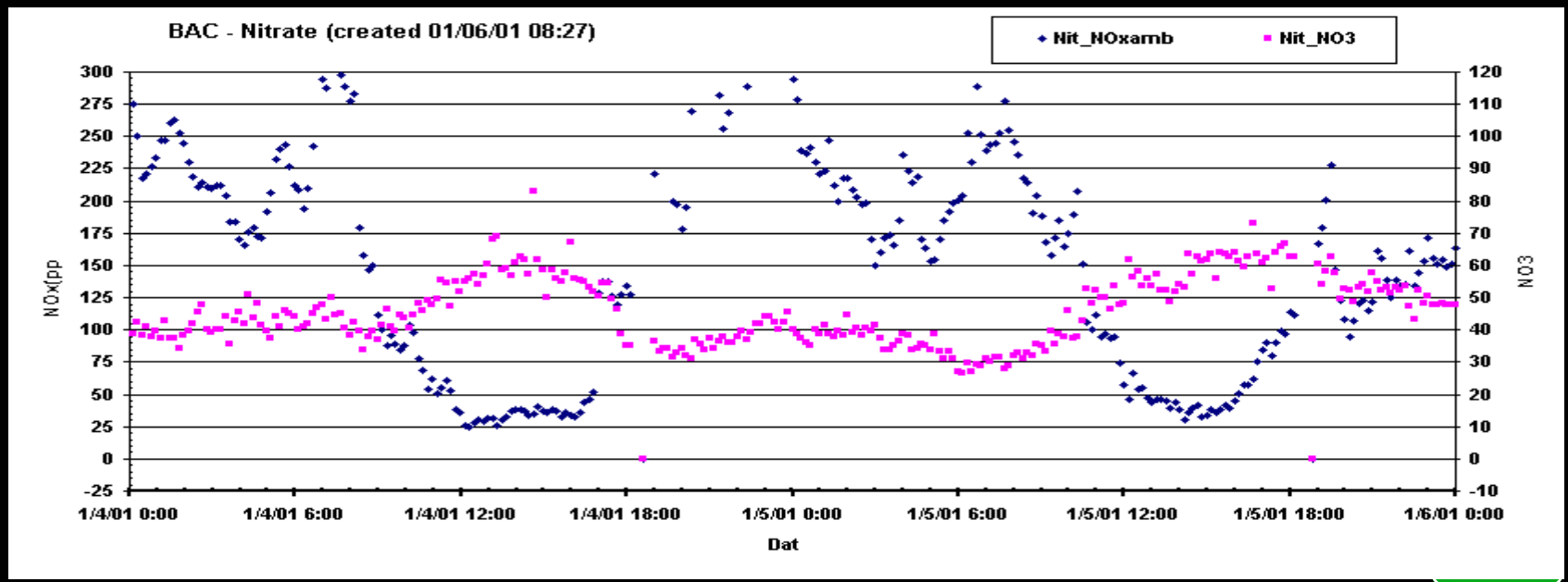
- 65%-90% PM2.5
- 35-61% Secondary Nitrate/Sulfate
- 14-33% Total Carbon
- 4-28% Geologic

Winter Episode Meteorology

- Surface high temperatures 49 to 68 degF
- Surface minimum temperatures 30 to 37 degF
- Warm aloft, cold on the surface
- Atmospheric mixing <500 feet for 16-21 hours
- 24 hour wind speeds 1.0-4.8 mph
- Vertical dispersion extremely limited

Understanding PM2.5 Formation and Emissions





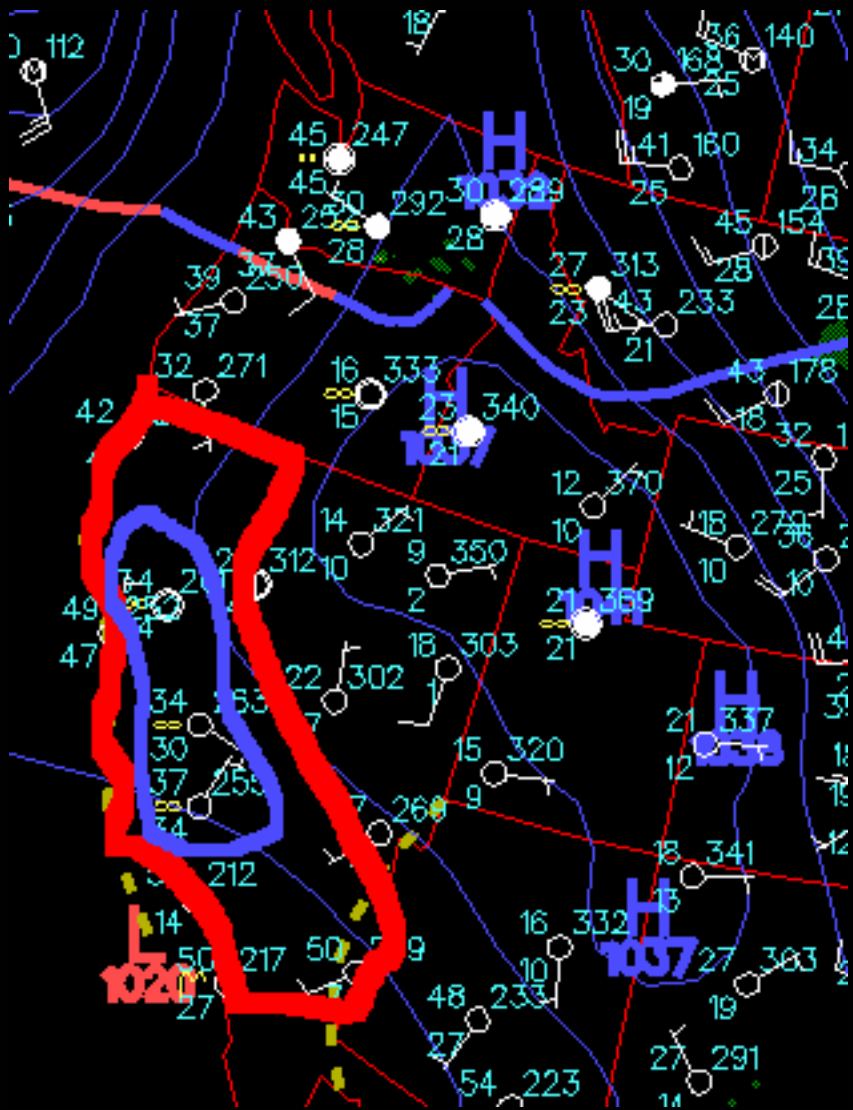
Winter Episode Synoptic Pattern

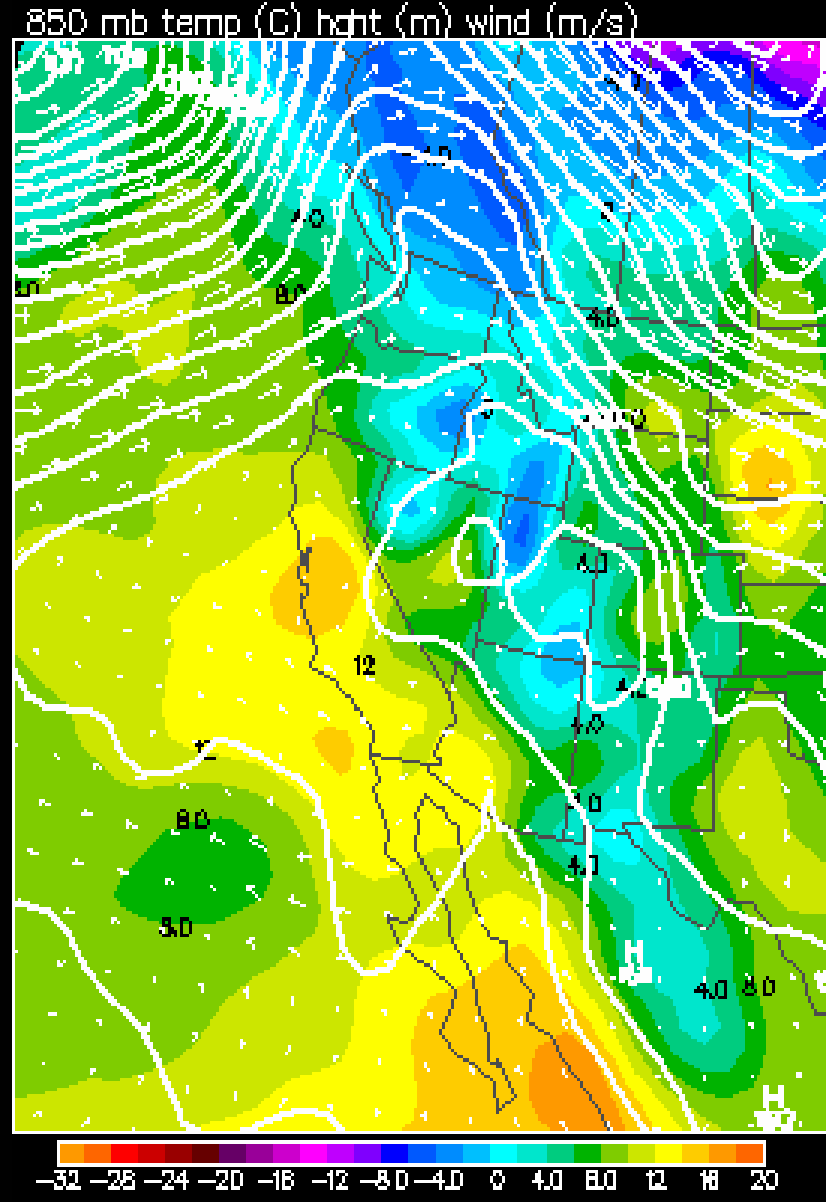
- Upper level high pressure center
  - ✓ East Pacific (2)
  - ✓ CA Coast
  - ✓ Pacific NW coast
  - ✓ Central CA
  - ✓ Nevada

Mesoscale Prediction

- Synoptic offshore conditions lead to weak wind flows and eddy's
- High pressure indicative of subsidence and radiation inversions
- Offshore flow results in cutoff of marine air and terrain blocking
- MM5 assists in prediction of these phenomena

January 4, 2001 Surface (34 degF) and Approximate 5000 feet (61 degF)





Forecasting Tools

- Synoptic models including MOS
- Mesoscale meteorological models
- Lower Air Profilers
- RAOB, aircraft, pibals
- Statistical Models
- Verification Displays

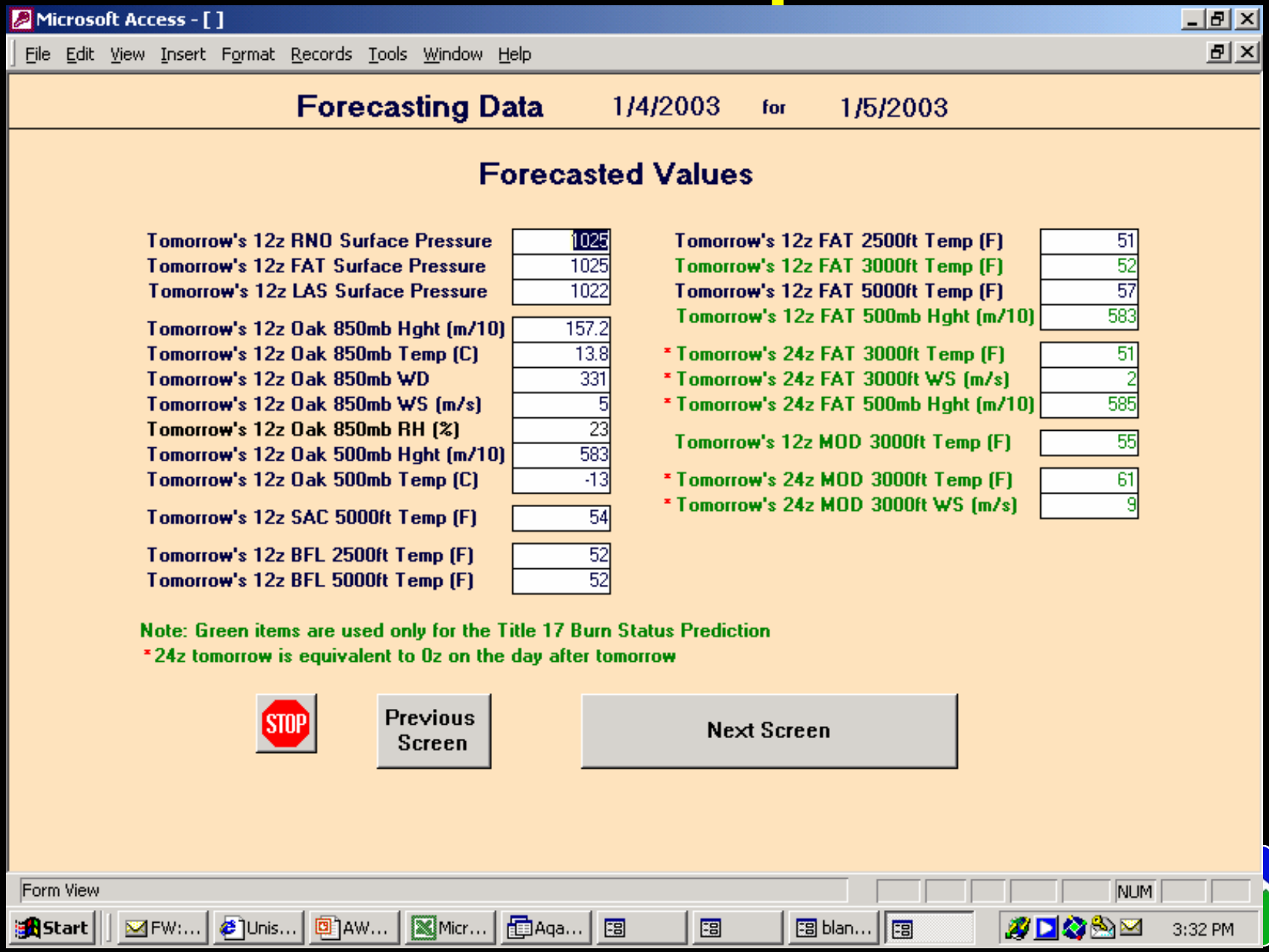
Meteorological Parameters That the Best Linear Relationship to PM2.5 (Seasonal)

- Stability parameter (T850-Tmin)
- Average 24 hour wind speed
- Spatial maximum temperature gradient
- 500mb Temperature
- Humidity

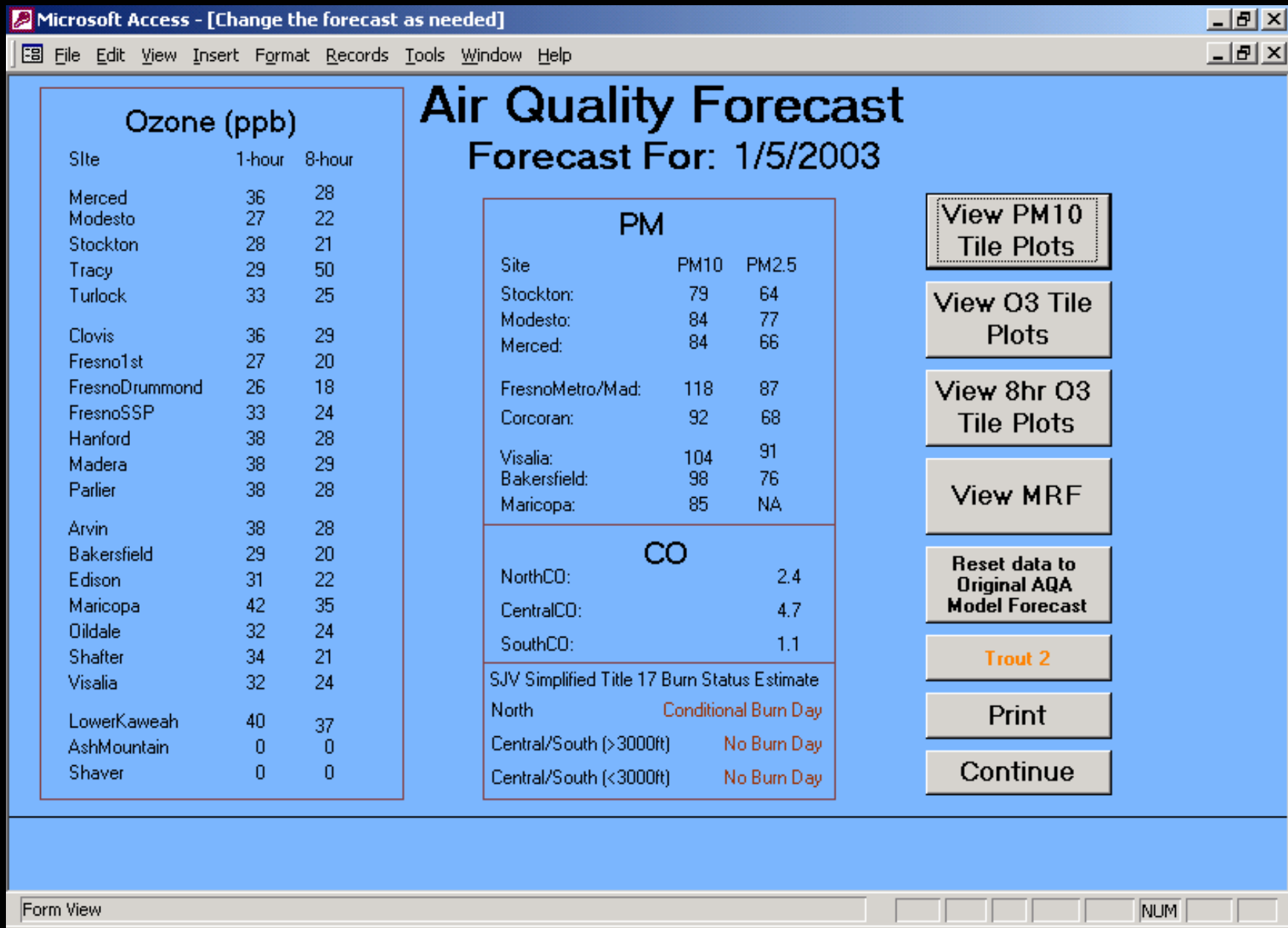
Multiple Regression R-Met. To FRM PM2.5

Site	Winter	Spring	Summer	Fall
Bak-CA	.76	.61	.46	.62
Bak-Air	.87	.37	.74	.79
Bak-Gol	.79	.53	.53	.63
Clovis	.39	.42	.55	.70
Corcoran	.65	.23	.46	.83
Fresno-1st	.59		.49	.62
Fresno-PC	.88	.45	.74	.77
Merced	.82	.56	.55	.72
Modesto	.74	.49	.38	.53
Stockton	.64	.51	.48	.74
Visalia	.72	.18	.54	.66

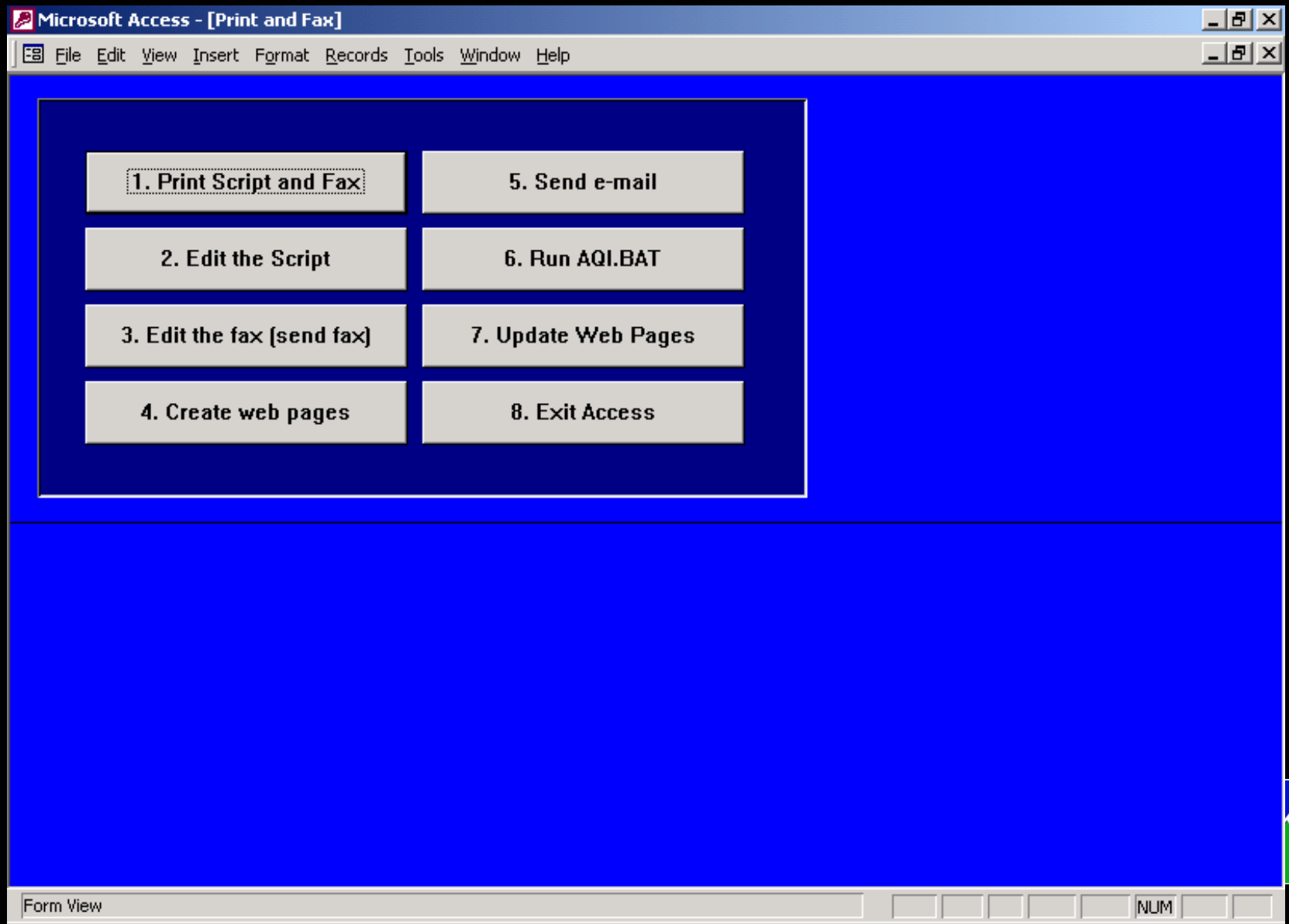
Forecast model input



Forecast Output and Edit

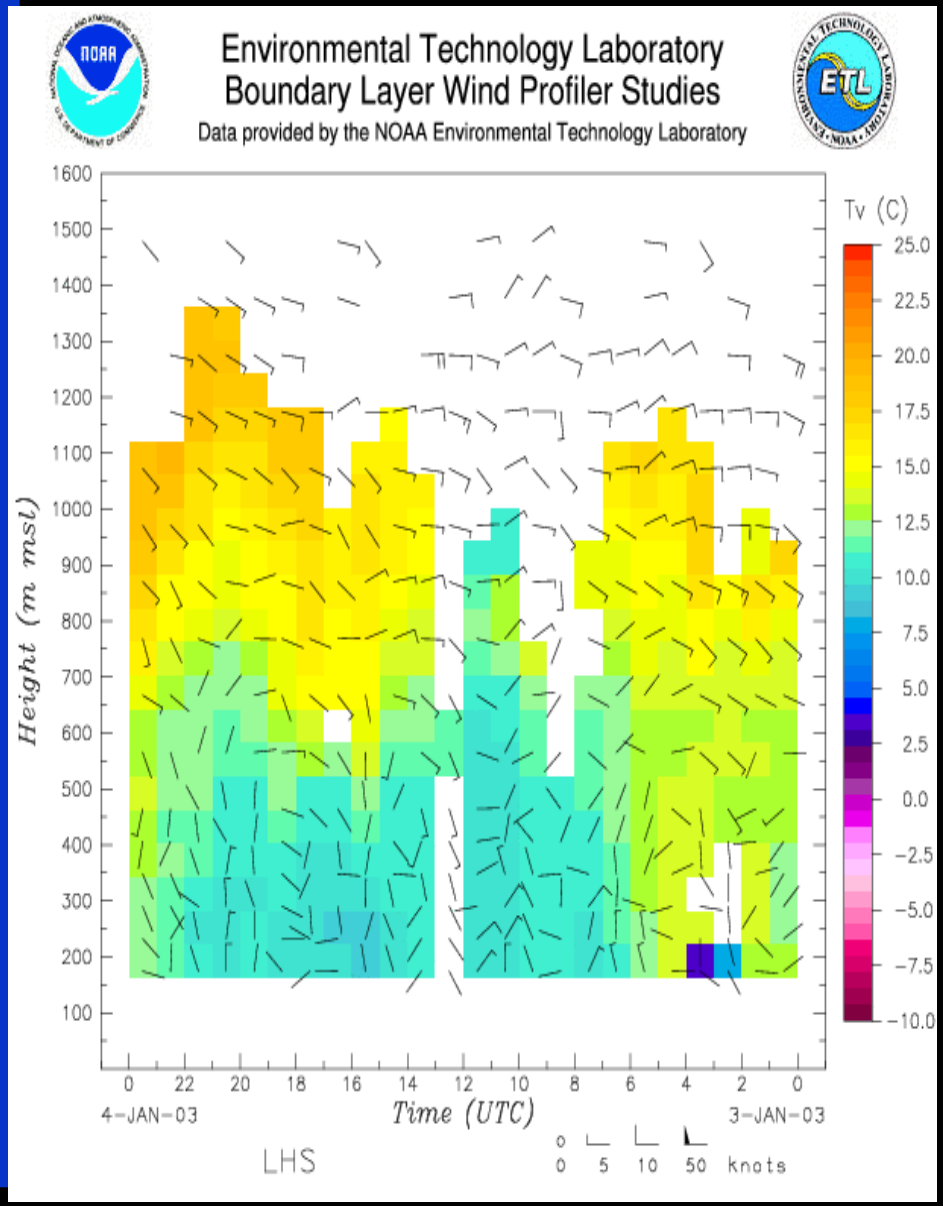


Information Distribution

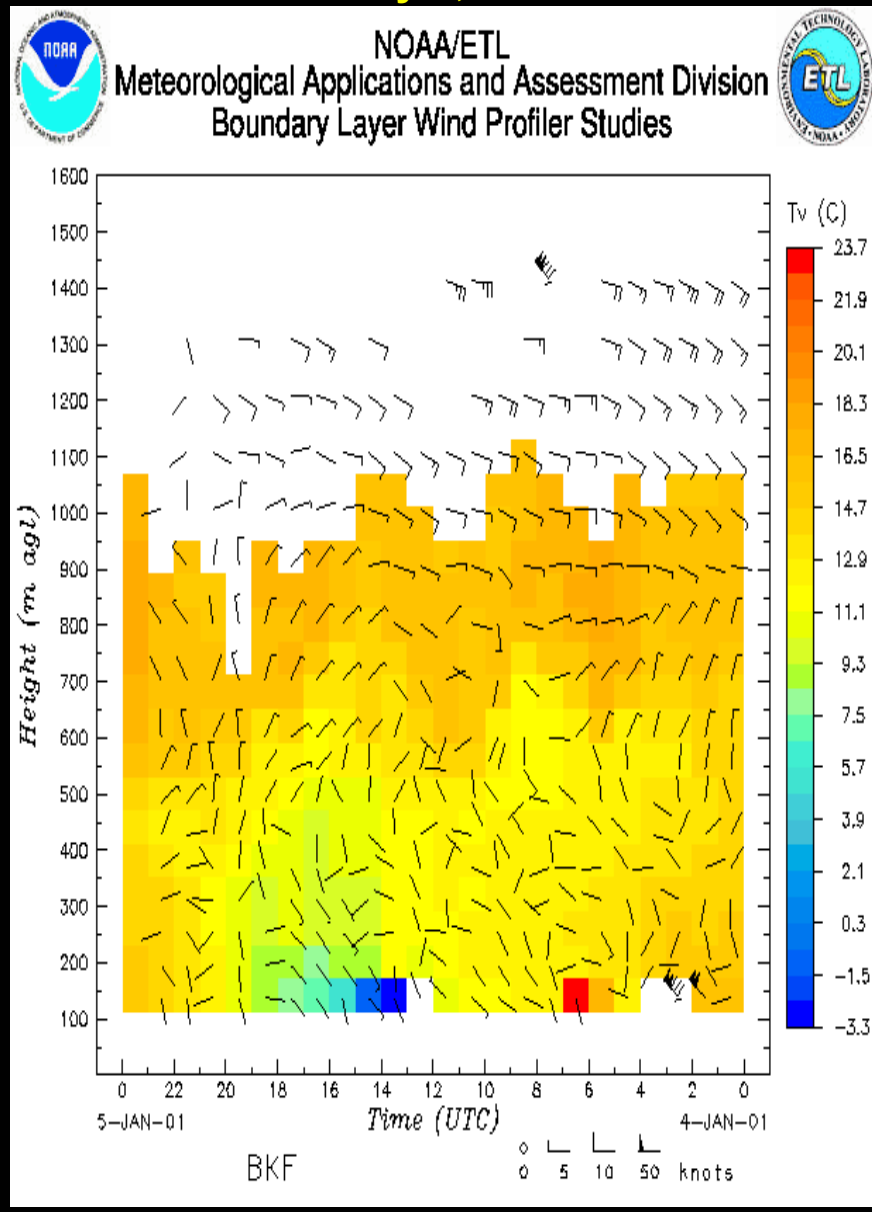


Lower Air Profiler Data

Lost Hills January 4, 2003



Bakersfield January 3, 2001

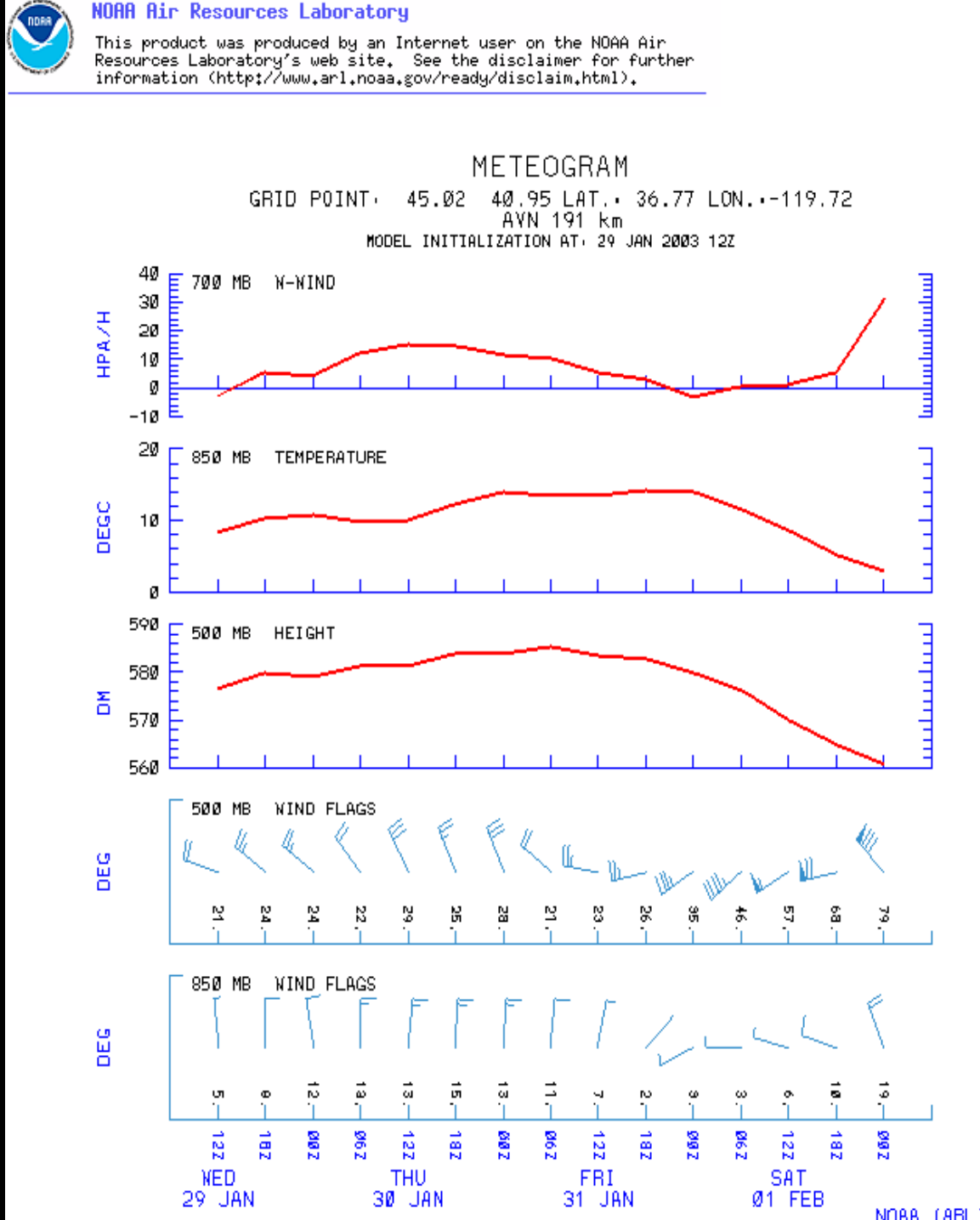


Basis for Five Day CRPAQS PM Forecast

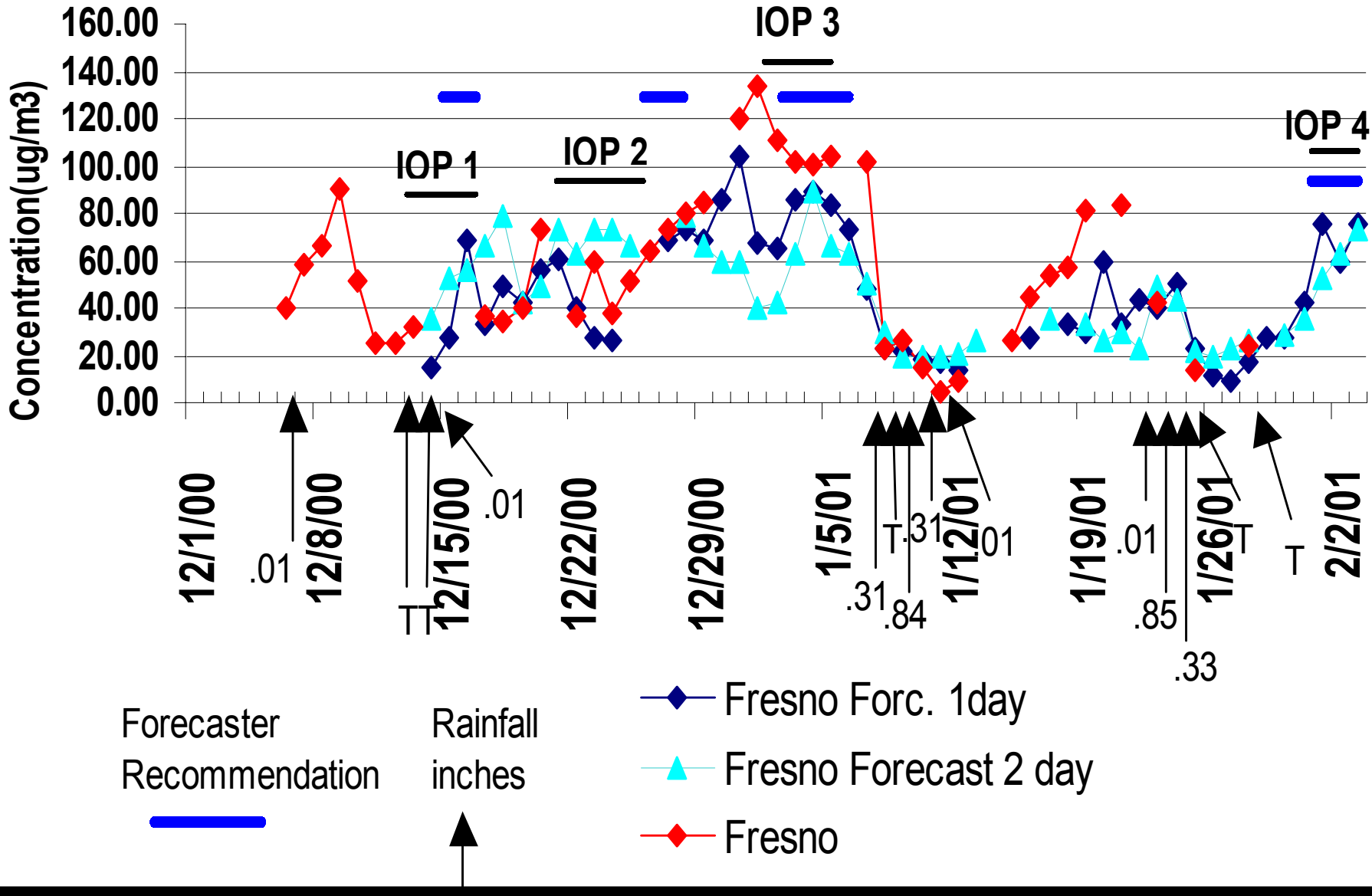
- Next Day PM10 forecast by regression then intuitively adjusted accounting for synoptic model performance and measured PM tends
- Ramped up and down by analysis of synoptic model patterns and regression parameters (e.g.--T850-min)
- PM2.5 forecast calculated by averaging measured PM2.5/10 ratios over the last 5 days at each site then intuitively adjusted

Use of Model Output Statistics from Synoptic Models:

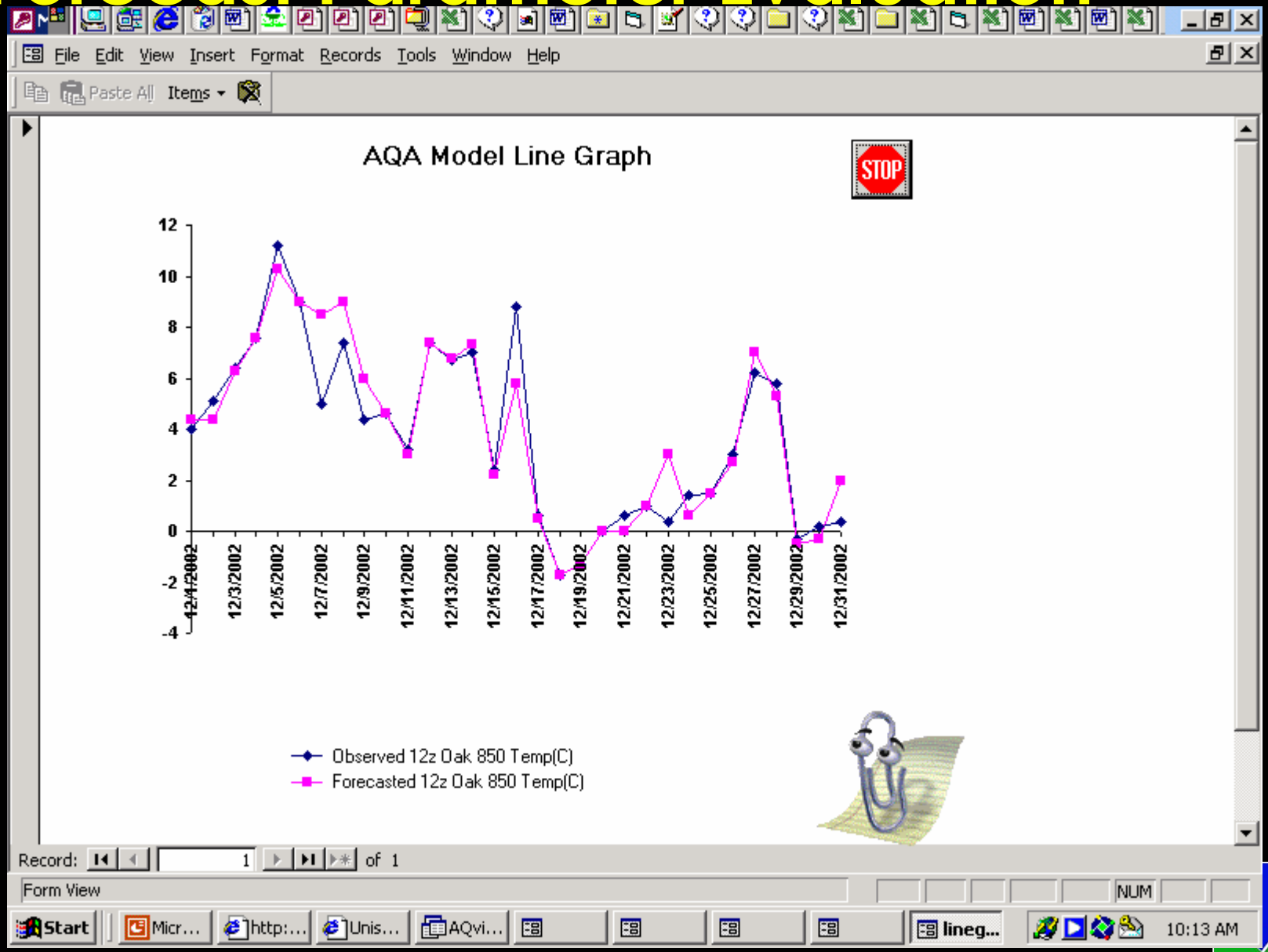
www.arl.noaa.gov



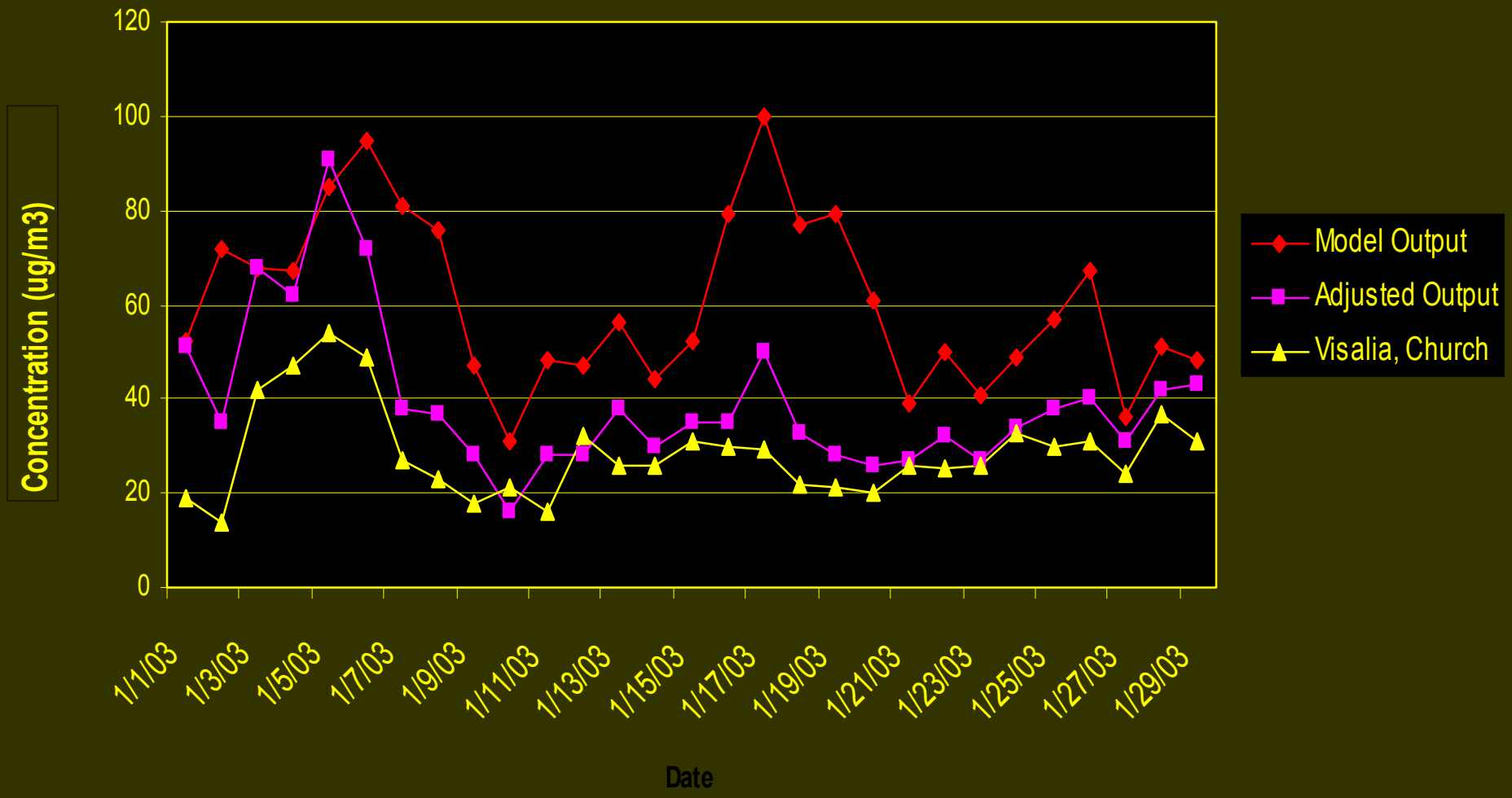
Fresno-One and Two Day PM2.5 Forecasts



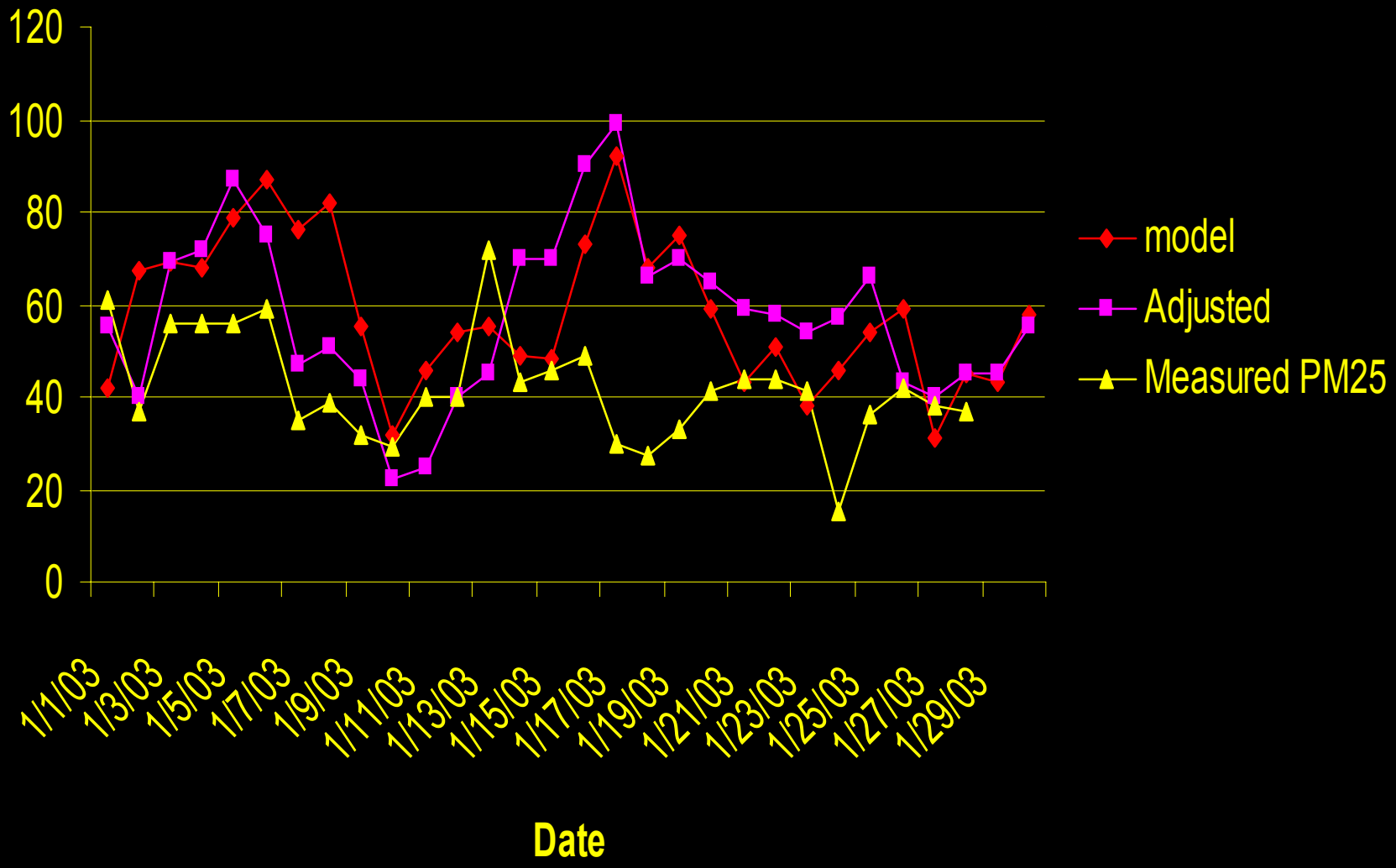
Forecast Parameter Evaluation



January 2003 PM2.5 Forecasts at Visalia



January 2003 PM2.5 Forecasts at Fresno-1st Street



Synoptic Discussion:

Surface: The morning surface chart indicate strong highs centered over the Four Corners Region and 500 NM southwest of Point Conception. A cold front curves southward along the West Coast from British Columbia to 600 NM west of San Francisco.

Aircraft Sounding: The morning aircraft sounding from Modesto shows a warmer air mass, with a strong inversion of 23 degrees Fahrenheit from the surface up to 3,000 feet0.

Upper: Upper level charts a strong high 700 NM west of northern Baja, with a ridge building northeastward into the Great Basin.

Air Quality Forecast:

A weak upper level disturbance will move into the Pacific Northwest during the next 24 hours, with very minimal impact on the Valley Floor. High pressure will strengthen across the Region on Sunday, with deteriorating dispersion conditions into early next week. Pollutants will steadily climb through the period, with the dominant pollutant being PM2.5 or 10 depending on location. AQI will be high unhealthy for sensitive groups in the northern region and unhealthy in the central and southern regions.

Burn Day Forecast:

In all **three regions, a no burn day will be declared tomorrow due to poor dispersion conditions. Strong stability aloft and light wind flow will lead to minimal smoke dispersion, thus resulting in a NO BURN DAY. In all three regions, an exceedance of the National Ambient Air Quality Standard for PM10 *is not* forecast for tomorrow.**

Please Don't Light Tonight:

Atmospheric dispersion conditions will be marginal tonight. Forecast PM10 and PM2.5 will not exceed PDLT criteria, as a result a Please Don't Light Tonight **will not be declared in all three regions tonight through 400 PM tomorrow afternoon.** Residential wood burning may lead to elevated levels on a small impact scale tonight.

Conclusions and Recommendations

- Generally cannot forecast the worst events
- Weather models generally too fast with trough cleanout
- Very rigorous systems were required to clean the San Joaquin Valley
- Factors such as wet deposition need to be addressed
- More real-time data needed including components of PM2.5